Energy Policy Act 2005
Section 2606
Wind/Hydro
Feasibility Study

January 13, 2009

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Agenda

- Western – Brief overview
- Wind Integration Activities
- Wind and Hydropower Feasibility Study Work Elements 1 through 4
- Discussion
- 15 Minute Break
- Wind and Hydropower Feasibility Study work elements 5 and 6
- Discussion
- Adjourn

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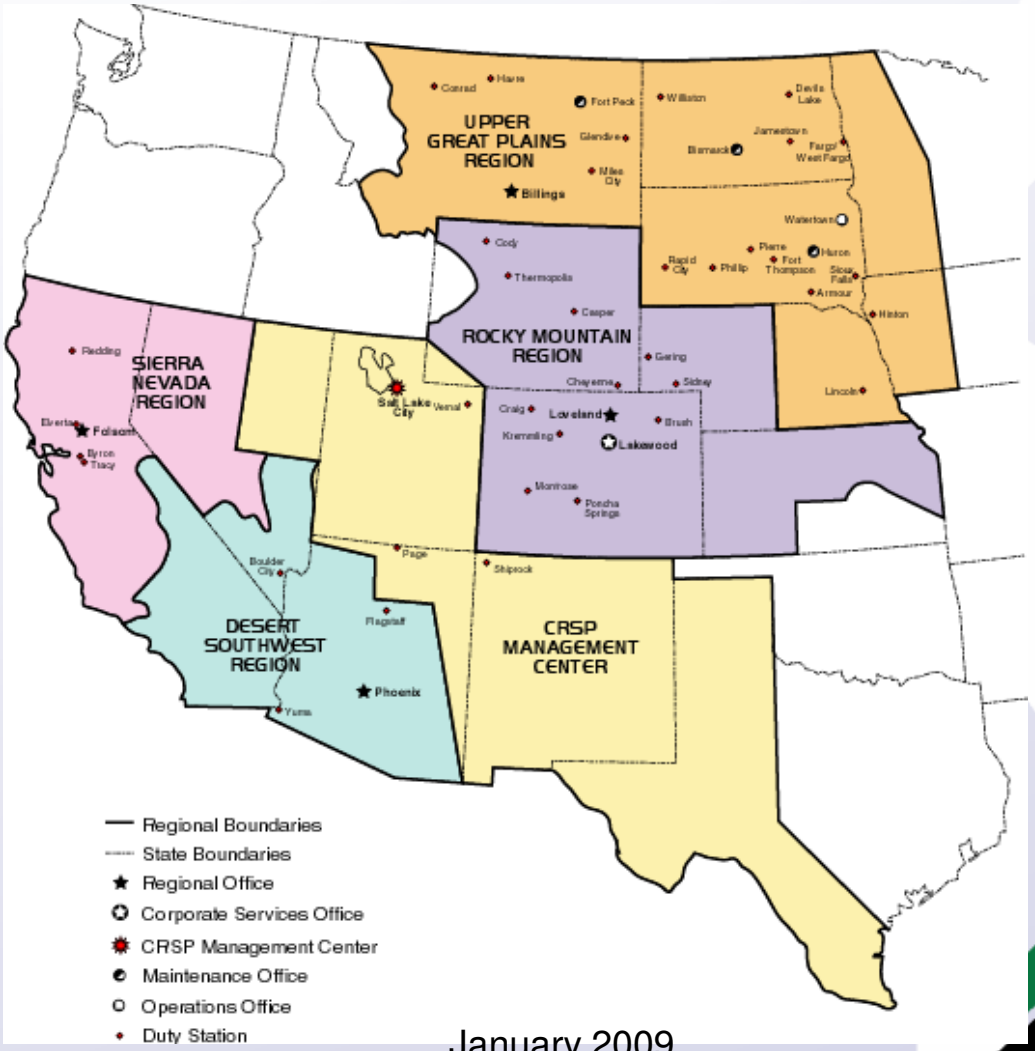
Western Today



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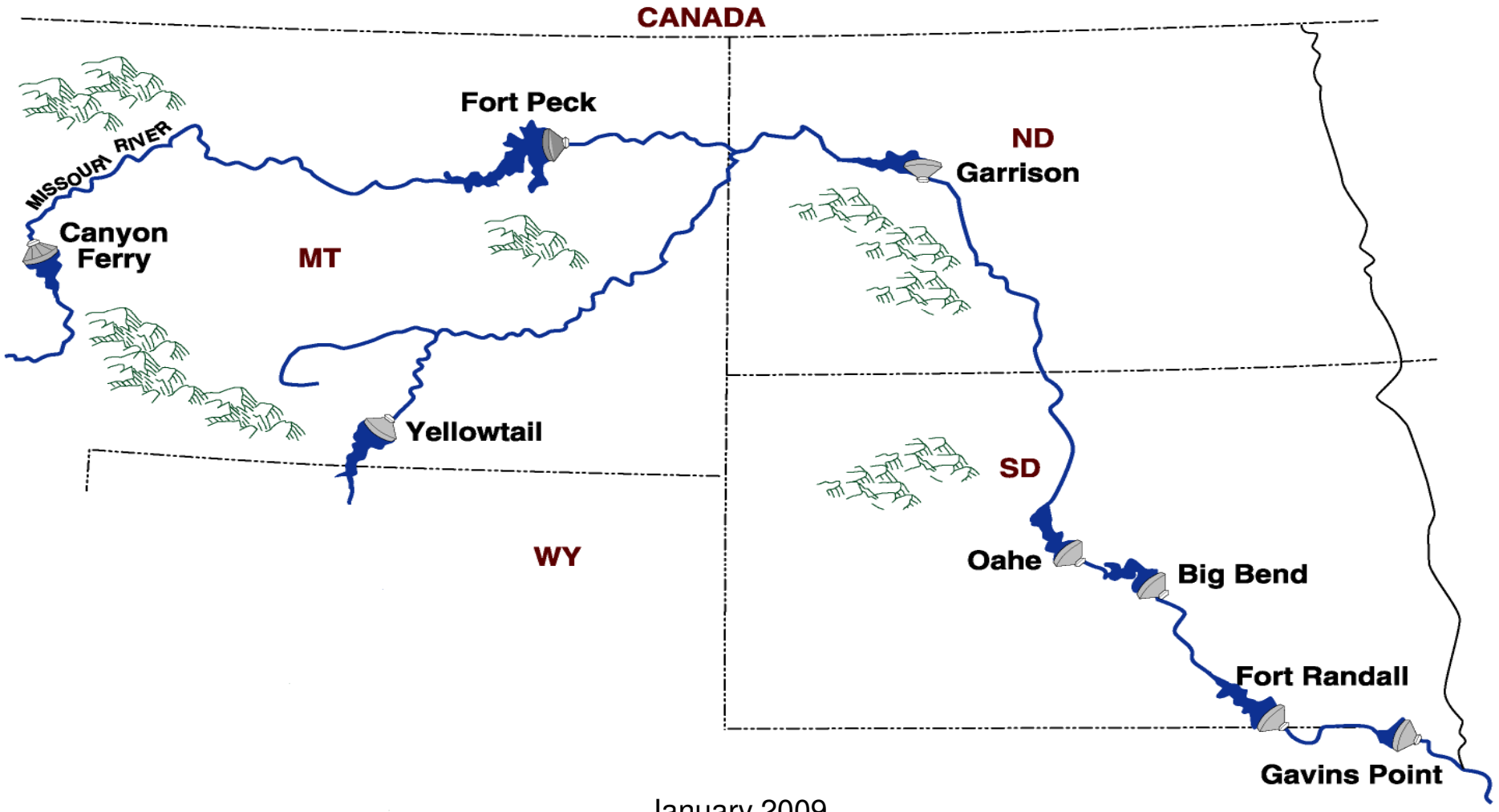
Hydro Generation Facilities



Upper Great Plains Region

- Market approximately 2,000 MW of capacity
- 378,000 square-mile service territory
- More than 300 firm power customers
  - Irrigation Districts
  - Municipal, Rural and Industrial Users
  - Municipalities
  - Native American Tribes
  - Public Power Districts
  - Rural Electric Cooperatives
  - State and Federal Agencies

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Power Marketing

- Power allocated under marketing plans
- Marketing plans are developed through public processes
- EPAMP subpart (c) – Power Marketing Initiative

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Western Wind Integration Activities

- Dakotas Wind Transmission Study
- WAPA Wind Integration Study (NREL)
- EPAct 2005, Section 2606, Wind Hydropower Integration Feasibility Study (WHFS)

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Dakota's Wind Transmission Study

- Evaluated available transmission capacities not Western use of wind energy
- Multiple site analysis; Garrison, Pickert, Leland Olds-Groton Tap, New Underwood, Ft Thompson, White, Mission
- Evaluated impacts of wind on NDEX, Ft Thompson and Watertown Interfaces
- 500 MW Non-firm transmission is available most of the time

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WAPA Wind Integration Study (NREL)

- Study objectives
  - Characterize Dakotas Wind Resource
  - Develop Wind Generation Models
  - Assess impacts on hydroelectric system operation
- Conclusions
  - Penetration of up to 200 MW would have quantifiable but modest impacts on the characteristics of control area demand
  - At the 500 MW penetration level the impacts become noticeably larger in magnitude
  - Impacts magnified at the 1000 MW penetration level
- Did not provide assessment of control area operations or how generation resources would be impacted

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Section 2606 Wind Hydropower Integration Feasibility Study Summary (WHFS)

- Objective – "Study the cost and feasibility of developing a demonstration project…"
- Three components
  - Physical Integration
  - Operational Integration
  - Economics
- Results/Findings
  - Reflect assumptions used in the study

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Initial Activities

- Formation of Project Team
  - March 2007 – Invitation to all Tribal and non-Tribal customers
  - May 2007 - Project Team formed
    - Blackfeet Tribe
    - Fort Peck Tribes
    - Rushmore Electric
    - Army Corps of Engineers
    - Bureau of Reclamation
    - Santee Sioux Tribe
    - Intertribal Council on Utility Policy
    - Heartland Consumers Power District
    - Nebraska Public Power District
    - National Renewable Energy Lab
  - May 2007 – Contract Awarded to Stanley Consultants Inc.

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WHFS Work Plan

- Six Work Elements (WE)
  - WE1 Work plan development
  - WE2 Analysis of historical operations
  - WE3 Wind project identification
  - WE4 Transmission system evaluation
  - WE5 Assessment of impacts (economics)
  - WE6 WHFS Draft and Final report preparation

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WE1 Work Plan Development

- Collaborative effort of project team members
  - Refined project scope
  - Identified key study requirements
- September 27, 2007 - Public meeting on Draft work plan
- November 5, 2007 - Final work plan

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WE2 Analysis of Historical Operations

- Historical runoff/power generation of Missouri River Mainstem Reservoir System
- Single week snapshots of generation/load
  - 1997 - High water/generation year
  - 2000 - Average water/generation year
  - 2005 - Low water/generation year

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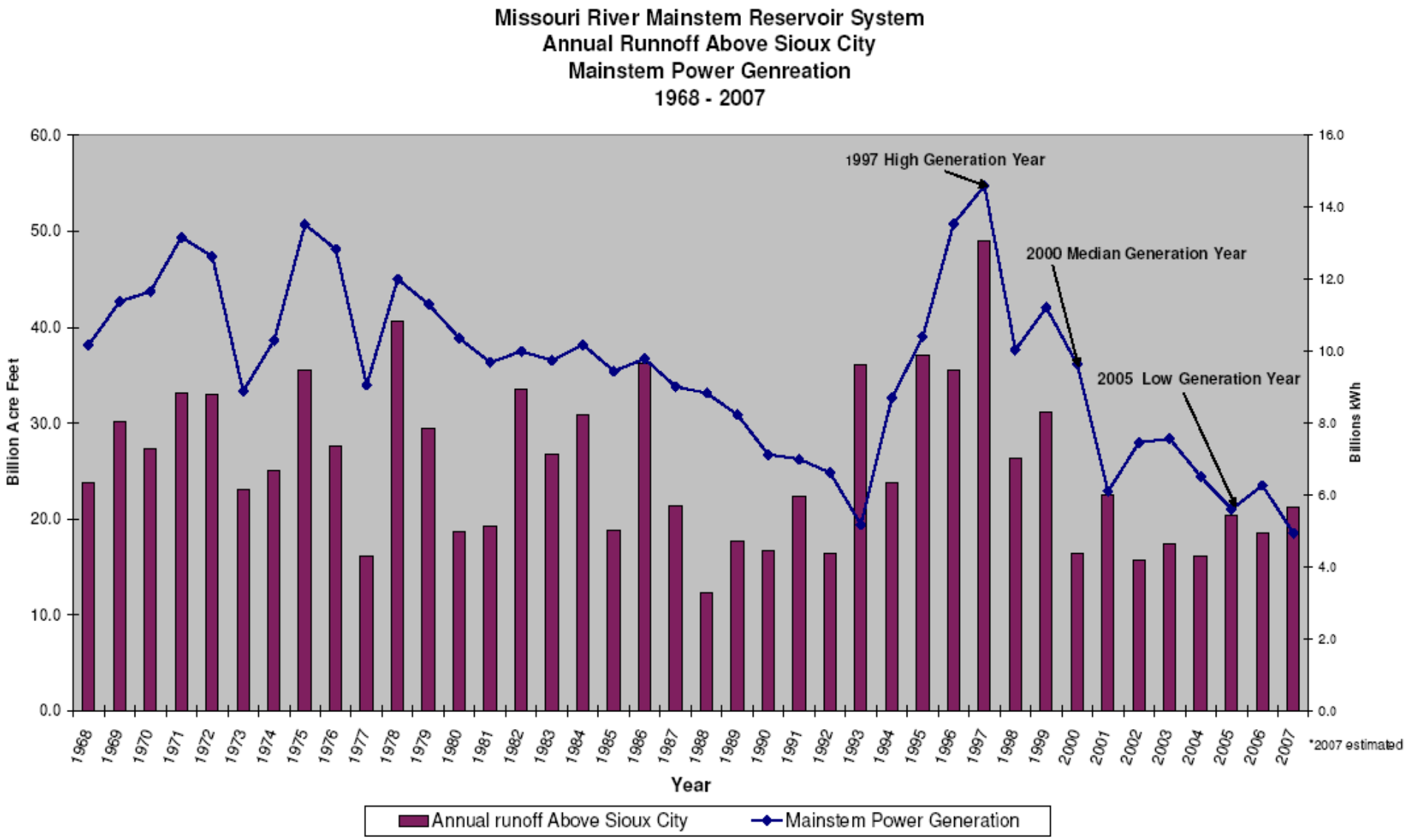
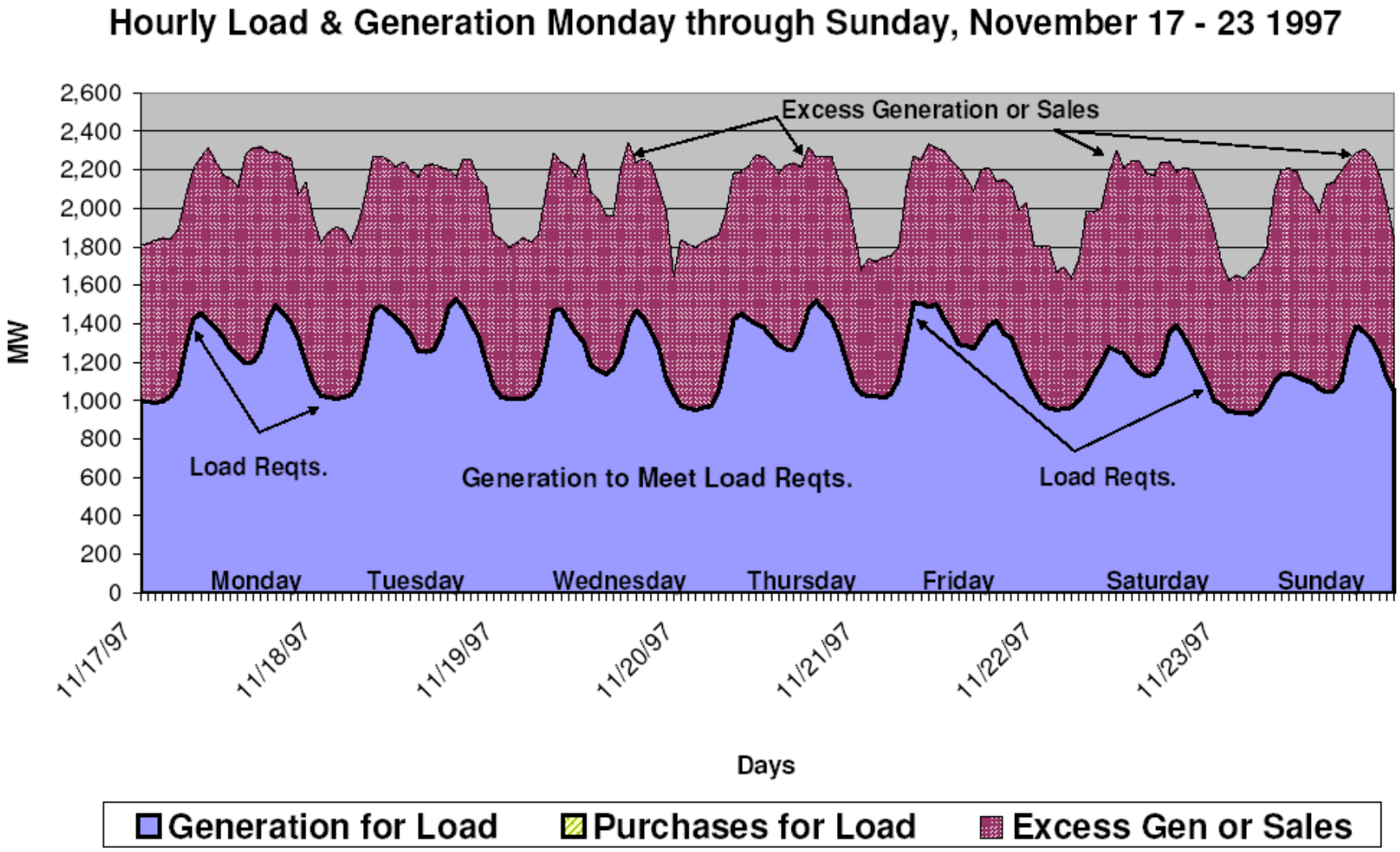
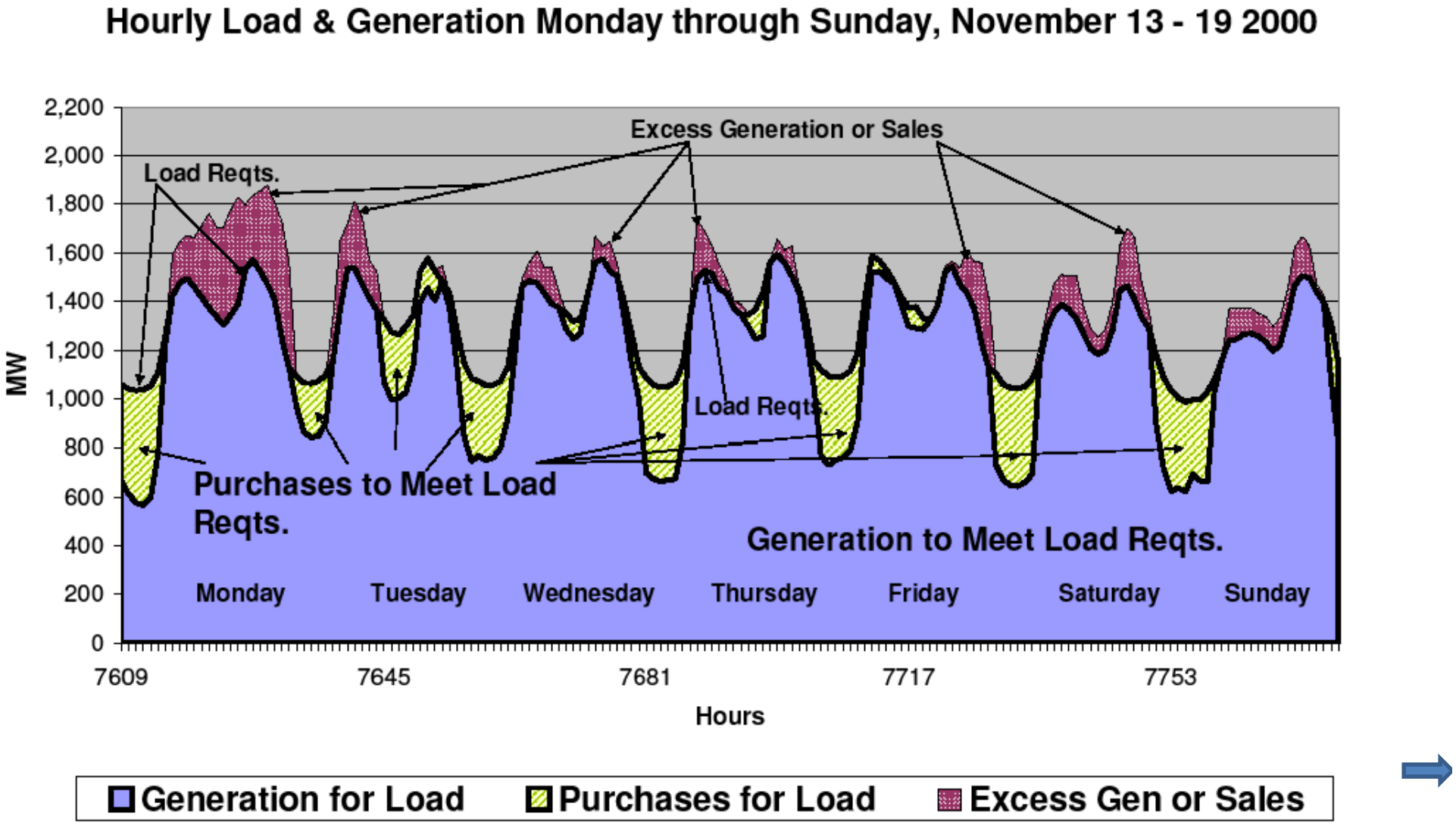
Corps Runoff-Gen comparison



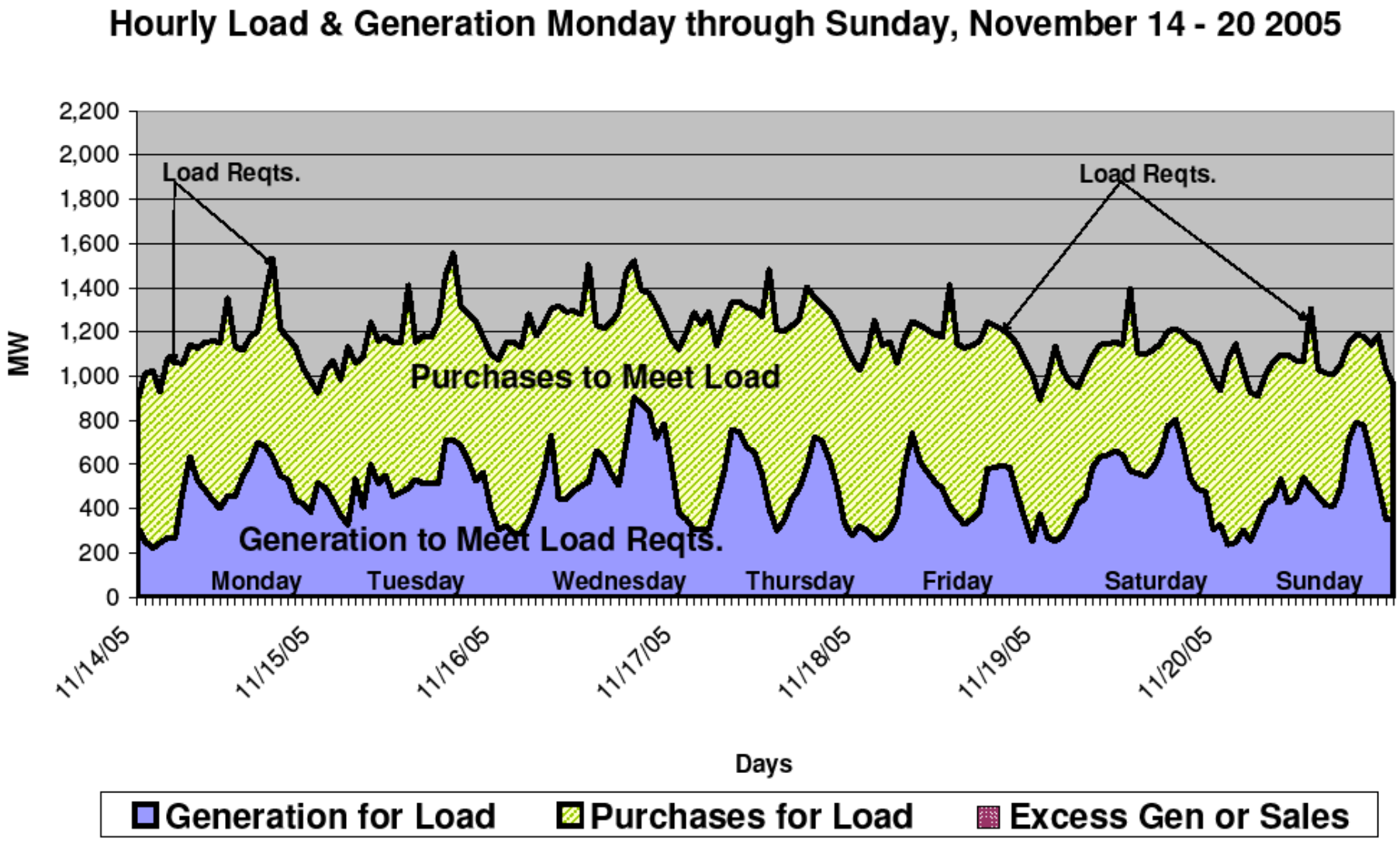
High Water Year



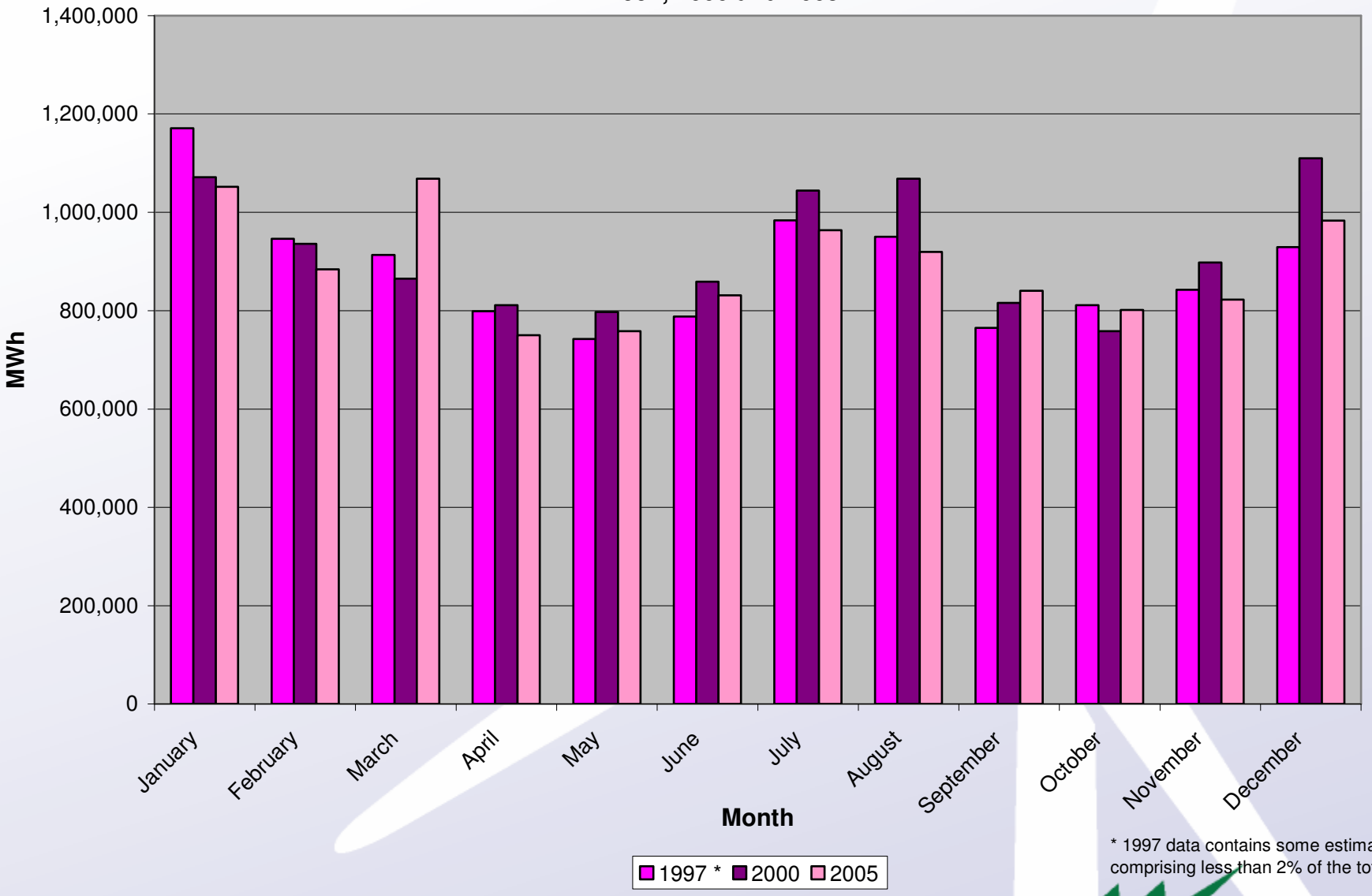
Average Water Year



Low Water Year



Western UGPR
Total Monthly Load
1997, 2000 and 2005



* 1997 data contains some estimates comprising less than 2% of the total load.

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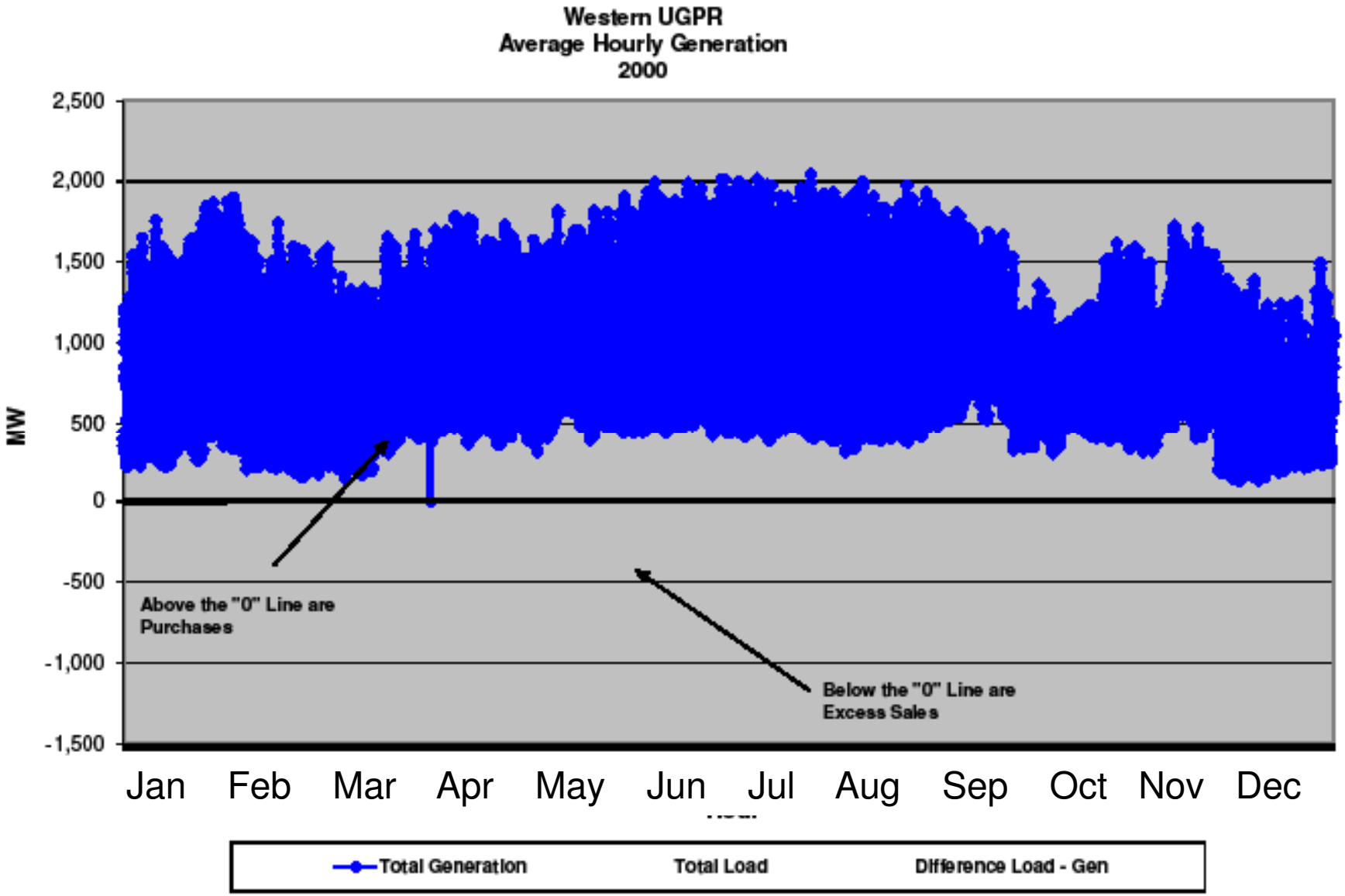
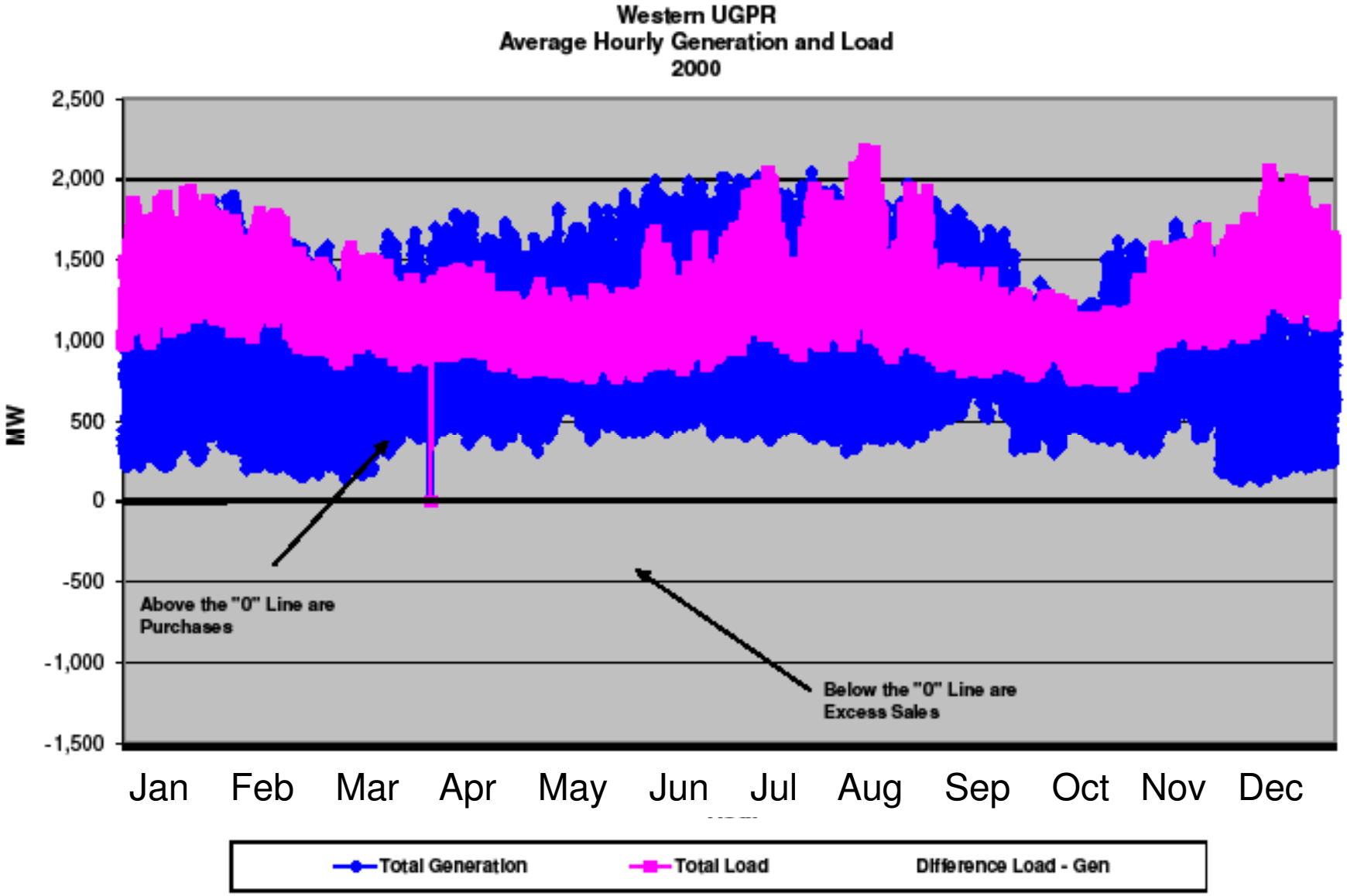
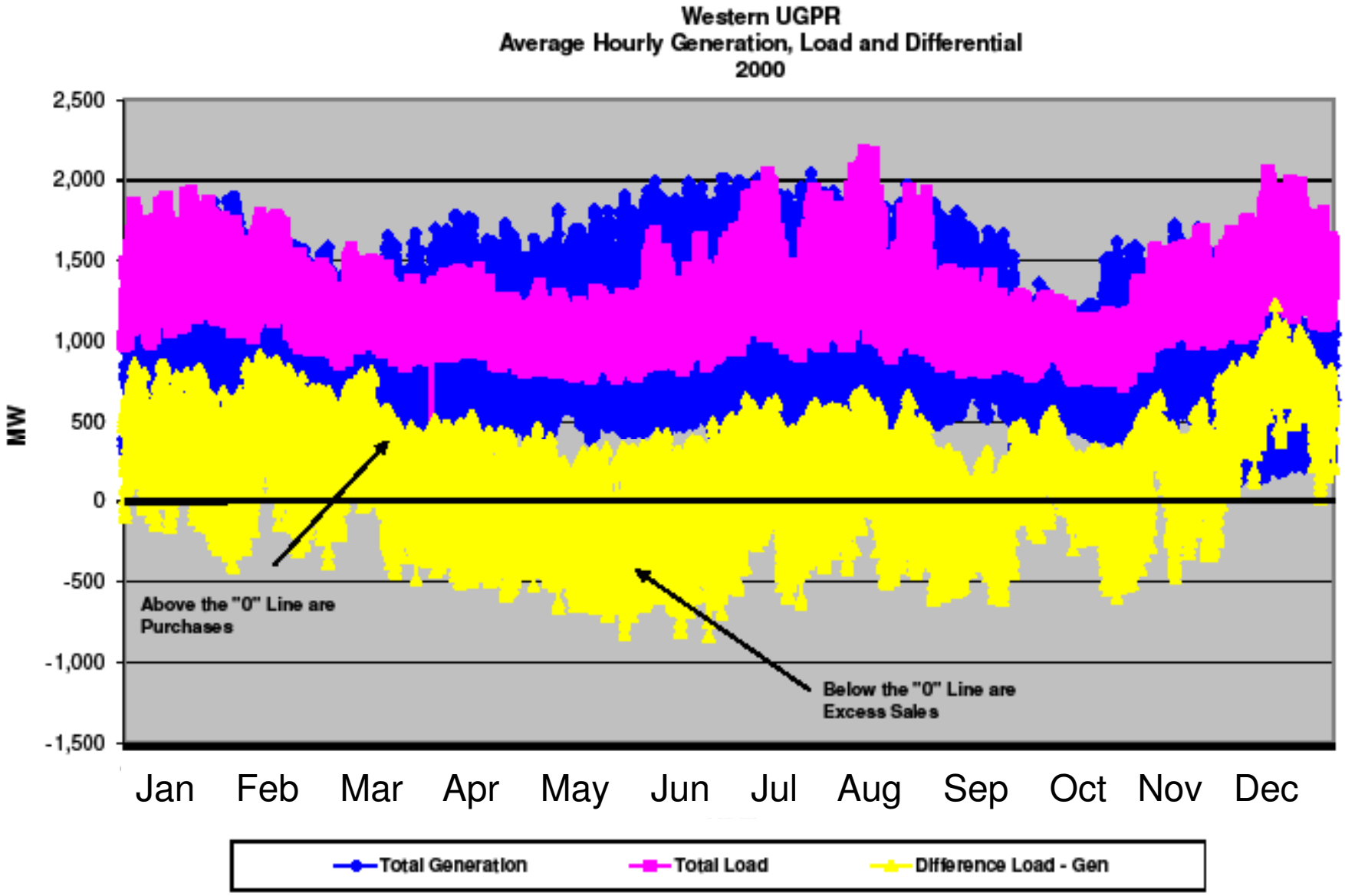
Average Water Year



Average Water Year



Average Water Year



Historical Operations Findings

- Identified a range/bandwidth for the capacity to offset historical purchases
- Key elements considered
  - Range of hydro generation scenarios
  - Western's consistent load patterns
  - Ability to utilize energy (remain a net user of energy)
- The initial integration range is 0 to 330 MW (this does not represent wind nameplate capacity)

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WE3 Wind Project Identification

- Tribal Wind Projects
  - 14 Reservations
  - 1 Inter-Tribal Organization
  - 18 Wind projects throughout the UGP Region
  - Project size envisioned 10 MW to 320 MW

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Tribal Wind Energy Development Potential

- Based on Questionnaires received for the WHFS
  - Projects range from conceptual through various stages of development
  - Potential initial development by 2011 = 748 MW
  - Post 2011 development 1,748 MW
  - Project development on reservations not included in WHFS assumed to be an additional 50 MW at each location
  - Total resource potential 2600 MW

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Tribal Wind Energy Profiles

- Wind energy profiles developed for each wind project received by the established deadline
  - Wind Production Modeling was necessary to evaluate
    - Transmission system impacts
    - Operational impacts
    - Economic analysis
  - Modeling conducted by 3TIER
    - GE 1.5 SLE Wind turbine power curve used in modeling for all sites
    - Produced hourly average wind speed and resulting energy production profiles

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Tribal Wind Potential Findings

- Tribal lands are located in wind resource areas suited for a demonstration project
- A significant resource potential exists from which a demonstration project could be competitively awarded if approved/funded

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WE4 Transmission System Evaluation

- Transmission system analysis approach
  - East/West grid modeled separately
  - Modeling followed established reliability criteria/protocol using approved model cases
- Conceptual interconnection costs
  - Assumed interconnection to available 115 kV, 161 kV or 345 kV
- Critical Assumption – system improvements relevant to other projects are in place

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Transmission System Analysis Findings

- East System
  - Representative 50 MW project injected into transmission system
  - Contingency analysis
    - Overloads
      - Lines – one less over the base case
      - Transformers – one additional over the base case
    - Voltages
      - Undervoltages – three additional over the base case
      - Overvoltages – no changes

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Transmission System Analysis Findings (cont'd)

- West System
  - Two projects totaling 89 MW injected into transmission system
  - Contingency analysis
    - Overloads
      - Lines – one additional over the base case
      - Transformers – no change
    - Voltages
      - Undervoltages – ten fewer over the base case
      - Overvoltages – no changes

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Transmission System Interface Analysis Findings

- Both East and West case analysis revealed no interface ratings were exceeded as a result of the addition of Tribal Wind generation
- Any project selected as a WHFS demonstration project will be subject to the Western Open Access Transmission Tariff (OATT) process and will require formal Feasibility, System Impact and Facility studies prior to actual interconnection and transmission service

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Transmission System Analysis Conclusions

- Injection of Tribal Wind in studied amounts does not result in overall grid additions
- Base case system violations resolved relative to other interconnection requests
- Conceptual interconnection cost $8.3M
  - Typical configuration of interconnection facilities (115 kV)
  - Assumes no additional transmission grid additions

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Brief Discussion

-

15 Minute Break

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WE5 Assessment of Impacts

- Conducted using a series of power market simulations using PROMOD IV simulation software
  - Zonal analysis – identify long term (30 years) economics of Tribal Wind integration
  - Nodal analysis – evaluate how Tribal Wind impacts overall system operations and transmission constraints

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Case Scenario Development

- Developed case scenarios
  - Reference case = 158 MW existing wind - No wind serving Western load
  - Base case of 723 MW = existing wind projects plus non-Tribal Wind projects reasonably assumed to be connected to the IS by the study year (2011)
    - 158 MW existing
    - 265 MW committed
    - 300 MW anticipated mid-term purchase for Western load
  - Tribal case of 773 MW = 723 MW base case wind plus 50 MW Tribal Wind demonstration project

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Case Design

- Compared
  - Three hydro generation system levels (low, average and high)
  - A no wind scenario and two wind scenarios (Reference, Base Wind and Tribal Wind)
- Western Load Obligations
  - Not subject to growth
  - Load/patterns show general consistency over time

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Power Market Simulation Development (PROMOD IV)

- Power market simulation used
  - Standard input assumptions for most data
  - Hydro-Generation Forecasts
    - Zonal-30 year averages
    - Nodal-Single year
  - Peaking contract energy returns
  - 30 year load and wind forecasts
  - Reserve requirements for wind penetration levels studied
  - Cost of energy (Tribal Wind project)
  - Carbon Legislation (penalties) in place

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Zonal 30 Year Forecast

- Forecast development
  - Utilized 40 years of hydro system operational data (1967-2007)
    - Low hydro – 7.838 billion kWh = 1998-2007 repeated 3 times
    - Base hydro - 10.265 billion kWh = 1967-1996
    - High hydro -12.068 billion kWh = 1967-1976 repeated 3 times

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Nodal Single Year Forecast

- Forecast Development
  - Utilizes Army Corps of Engineers projections through 2011
    - Low hydro - year selected 2007 with 5.744 billion kWh
    - Base Hydro - year selected 2000 with 10.211 billion kWh
    - High hydro - year selected 1997 with 15.267 billion kWh

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30 Year Load and Wind Forecasts

- Developed a representative load/wind year utilizing Western historical load data, wind data from Western's data archive and 3TIER simulated wind energy – matched for the year 2000
  - Forecasts based on two wind cases previously described
  - Forecasts are a representative profile and not intended for use as a metric for wind energy potential in the region

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Reserve Requirements

- The wind penetration levels assumed for the WHFS (723 MW Base Wind and 773 MW Tribal Wind) represent penetration levels of 23 percent and 25 percent respectively
- Sub-hourly analysis conducted to determine additional load following requirements for
  - Reference (existing) wind
  - Base Wind
  - Tribal Wind

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Sub Hourly Analysis Findings

Average Load Following Requirements

Scenario	98% CPS2 Perfect Forecast	98% CPS2 Forecast Error	95% CPS2 Forecast Error
Reference Wind (158 MW)	18.5 MW	18.5 MW	18.5 MW
Base Wind (723 MW)	28.0 MW	73.5 MW	42.0 MW
Tribal Wind (773 MW)	29.4 MW	77.2 MW	45.2 MW
Adding 50 MW of Tribal Wind to the Base Wind case requires			
Additional load following Reserves	1.4 MW	3.7 MW	3.2 MW

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Cost of Energy – Tribal Wind Project

- Establish a theoretical cost of energy for a 50 MW Tribal Wind project
  - Utilized two different industry accepted wind project calculators
    - Produced two estimates using each calculator – one with production tax credit (PTC) and one without
    - Estimate was completed using assumptions agreed upon by project team members
  - Energy cost estimate of $0.05/kWh used (2011)
    - Includes PTC
    - Does not include value of REC
    - Excludes cost of transmission interconnection

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Market Simulation Results

- Nodal Results for Base Wind and Tribal Wind cases as compared to the Reference Wind case
  - No additional constraints on flowgates
  - No significant increase in number of binding hours
  - No significant risk of wind curtailment due to transmission

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Economic Analysis

- Net costs to Western from Zonal results
  - 30 year simulations discounted 5 percent into net present value (NPV)
  - REC values included ($5 initial value/5 percent escalation)
  - Transmission O&M costs included (10 percent of capital cost/4 percent escalation)

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30 Year Net Present Value Results

All values are 2011 $k		Reference Wind 158MW	Base Wind 723 MW	Tribal Wind 773 MW
Low Hydro	Total 30 Year NPV Costs	$6,093,513	$5,983,030	$5,981,847
	NPV Annual Avg.	$203,117	$199,434	$199,394
Base Hydro	Total 30 Year NPV Costs	$4,631,137	$4,589,942	$4,601,929
	NPV Annual Avg.	$154,371	$152,998	$153,397
High Hydro	Total 30 Year NPV Costs	$3,475,429	$3,496,623	$3,521,275
	NPV Annual Avg.	$115,848	$116,554	$117,376

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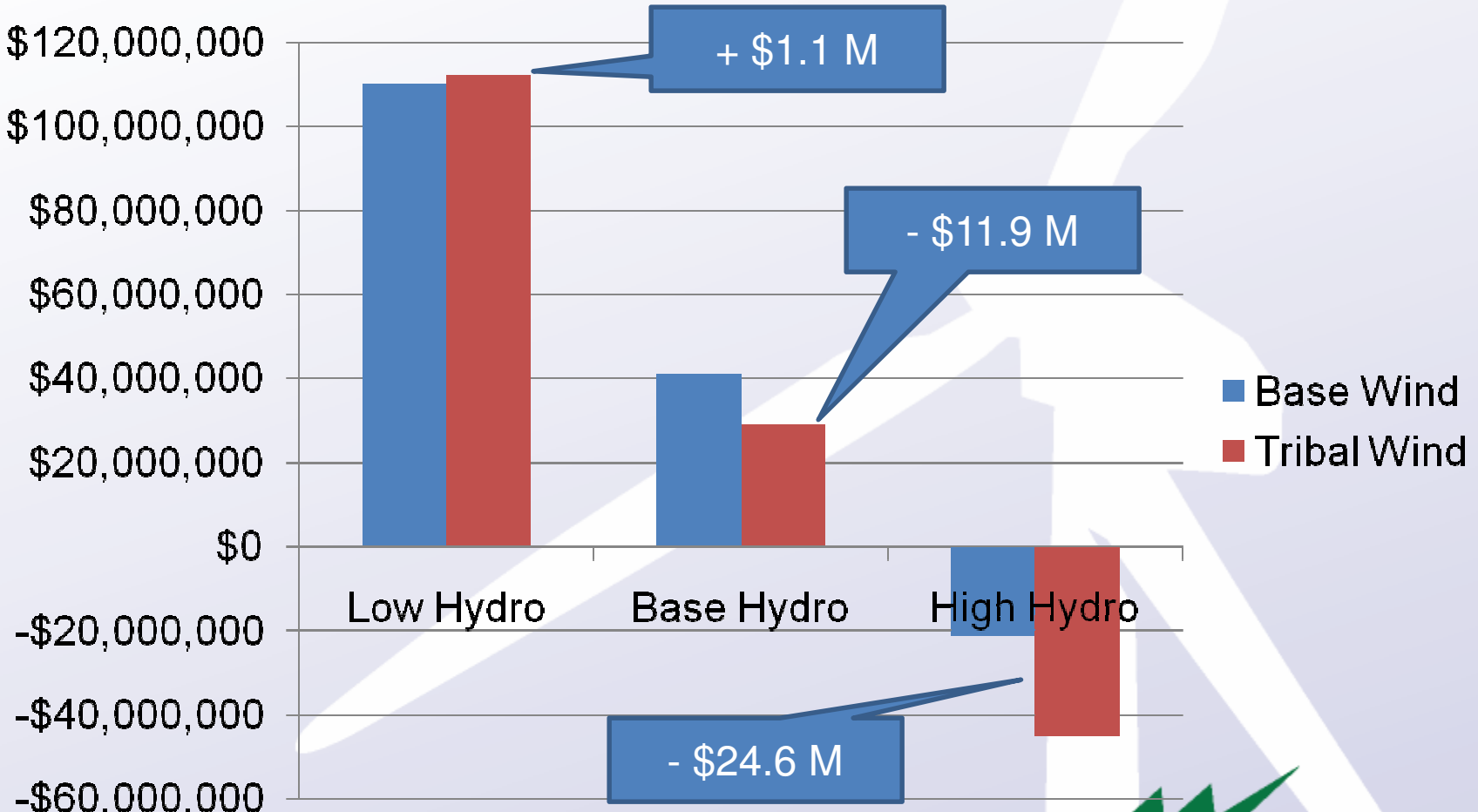
Net Present Value Comparison

- Comparison of Reference to Base and Reference to Tribal:
  - Low Hydro
    - Base Wind saves $110M over 30 years ($3.6M annually)
    - Tribal Wind saves $112M over 30 years ($3.7M annually)
  - Base Hydro
    - Base Wind saves $41M over 30 years ($1.3M annually)
    - Tribal Wind saves $29M over 30 years ($973K annually)
  - High Hydro
    - Base Wind costs $21M over 30 years ($706K annually)
    - Tribal Wind costs $45M over 30 years ($1.5M annually)

NPV Comparison - Continued

- Comparison of Base Wind to Tribal Wind
  - Low Hydro
    - Tribal Wind saves $1.1M over 30 years ($39K annually)
  - Base Hydro
    - Tribal Wind costs $11.9M more over 30 years ($400K annually)
  - High Hydro
    - Tribal Wind costs $24.6M more over 30 years ($822K annually)

30 Year Savings/Costs Between Reference Case and Base/Tribal Wind Cases



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Impact of Carbon Legislation

- One additional set of cases was run that excluded a carbon penalty
  - BaseHydro/BaseWind
  - BaseHydro/TribalWind
- Results are somewhat counterintuitive
  - No carbon penalty market resulted in increased costs of approximately $1.2B over 30 years ($40M annually)

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Impact on Reservoir Fluctuation

- Overall hydroelectric operations are governed by the Missouri River Mainstem Reservoir System Master Water Control Manual
- Annual operations follow the Annual Operating Plan developed each year by the Army Corps of Engineers

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Reservoir System Uses

- Hydroelectric generation is a by-product of other system purposes; flood control, upstream beneficial consumptive use, downstream water supply, navigation, recreation and wildlife
- The need to “move water” for other purposes is the driving factor behind hydroelectric production

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Impact of Wind on Reservoir Fluctuation

- The addition of Wind is not expected to change long term reservoir management practices
- Wind may have short term impacts on real-time operations and could effect scheduling over several days

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Flexibility of Reservoir System

- The addition of wind is not expected to provide additional flexibility in overall reservoir system management
- Western has and makes use of existing flexibility in the daily operating orders
  - Generation Profile

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Key Conclusions

- The economic simulations indicate the calculated capacity range of 0-333 MW (816 MW nameplate) does not identify the theoretical optimal level of cost savings to Western customers
- Carbon legislation plays a significant role in the economics of wind and hydropower integration

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Recommendations

- A demonstration project, if authorized and funded, be of no more than 50 MW nameplate capacity in size
- Any costs of the demonstration project beyond what Western would have normally paid for like energy should not be borne by Western's ratepayers
- Additional study is required to refine the economic saturation point for wind to serve Western load (including impacts of carbon penalty legislation)

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Benefits of a Demonstration Project

- A 50MW Tribal Wind project would:
  - Provide an opportunity to develop and test standards and terms for mutually beneficial Federal/Tribal/Customer partnerships
  - Provide long term benefits from a source of renewable energy
  - Mitigate a portion of the uncertainty of future energy costs
  - Produce economic benefits of renewable development on tribal lands
  - Enhance energy security through reduction of dependency on fossil fuel energy

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Next Steps

- Public comment Period closes February 13
- Response to comments (2-4 weeks)
- Prepare Final Report to Congress (2 weeks)
- Submit Final Report (May 09)

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Submission of Written Comments

- Send written comments to:

  Mr. Robert J. Harris

  Regional Manager, Upper Great Plains Region

  Western Area Power Administration

  2900 4th Ave. North

  Billings, MT 59101-1266

- Comments may be submitted via e-mail:

  UGPWindHydroFS@wapa.gov

- Wind Hydro Study Web Address

  http://www.wapa.gov/ugp/PowerMarketing/WindHydro/Default.htm

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